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ABSTRACT

A study was conducted to determine the SMOG readability formula scores of currently available patient education materials. It was hypothesized that the reading level of the materials would be higher than 7.5, the reading level of the average American citizen; and that there would be a significant reduction in the measured document reading levels if key terms were assumed to be known (pre-taught) and were counted as one syllable words on the SMOG. The SMOG readability grade levels of 10 sample education pamphlets dealing with respiratory diseases were determined. Results indicated that the lowest SMOG grade level on the materials was 2.92 levels above the population mean, 7.5; and that assuming knowledge of key terms and counting them as one syllable words for SMOG calculations reduced the lowest level to 1.98 grade levels above 7.5. The results suggest that readability formulas have a potential role in the evaluation of patient education materials, but that this potential may be limited to serving as a guideline. They also suggest that assessment of the patient's educational level be incorporated into patient evaluations, and that the inclusion of a vocabulary at the beginning of each document would result in a more readable and therefore more valuable document. (HTH)

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The Use of Readability Formulas in Patient Education Materials

Presented at the American Association for Respiratory Therapy Summer forum
(Reno, Nevada July 26-28, 1985)

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The Use of Readability Formulas in Patient Education Materials

(abstract)

In light of recent trends for early discharge and subsequent increases in home care patient populations, the need for adequate patient education has become apparent. A major source of such patient education is through the use of printed patient education material (PEM). The adequacy of such materials has seldom been addressed. Among the measures of adequacy is the ease of comprehension. A major factor in determining comprehensibility is that of the reading difficulty level of the text. It is generally recognized that a grade level score or index of 6.5 to 8.5 is readily comprehended by the majority of adult Americans. Several formulae exist which have been shown to be reliable predictors of reading grade level. The current study applies the SMOG Index and Standal's procedure to PEMs gleaned from voluntary agencies, corporate sources, and three major teaching hospitals in the Kansas City area.

Analysis of 10 representative PEMs revealed a mean SMOG Index score of 12.38 (+/—1.05) for the material analyzed. Adjusting the formula on the assumption that patient educators would define technical vocabulary terms resulted in a decrease in the SMOG Index to grade level 11.23 (+/—0.99).

The authors conclude that the SMOG Index is a useful tool in determining the appropriateness of printed PEM. We also concluded that the reading grade level of PEMs may be beyond the skill level ability of the majority of our potential clientele. The authors suggest that further research include a broader based sample.

Introduction

Since the advent of Diagnostically Related Groups (DRGs) and Prospective Payment Systems (PPSs) there appears to be a net decrease in the Average length of Stay (ALOS) during the hospitalization of COPD patients. Tyler has shown that for those DRG classifications (87, 95, 96, 97, 98) representative of COPD patients, there has been a mean decrease of 1.2 patient days.[1] One effect of the more rapid discharge of these patients; and of the reimbursement structure, is an increase in the numbers and a decrease in the relative "wellness" of patients receiving or needing home care. (e.g. Patients are being discharged sooner and in a less stable condition). Mathews reports, based upon Veterans Administration and U.S. Census Bureau data and subsequent projections that; "even using conservative estimates there may well be over 300,000 actual or potential users of home oxygen in the U.S."[2] It is probable that, given the aging of the population, these figures will see a dramatic increase in the coming decade and will remain relatively high for the rest of the century.

Given the projected increase in the home care population the need for patient education in relation to their disease and the treatment of their disease will also increase. Current practice in this area relies heavily upon the use of patient education pamphlets and booklets. It seems apparent that the usefulness and efficacy of such material is to a large measure dependent on how well the patient, his family, and his friends and associates assimilate, understand, and put into action the content of such materials. A significant factor in the assimilataion, understanding and implementation of the

information contained within the printed materials is the readability of the document.

In order to determine the readability of currently available patient education materials, a study of a sample of such documents was designed. The question: "How easy to read are patient education materials?"; was approached through the research hypothesis which stated that the reading grade level of patient education documents will exceed the reading level ability of the average American citizen. A second hypothesis addressed the question; "Will use of a modified scoring system which accounts for vocabulary teaching result in a significantly lower reading grade level score?" The hypothesis stated that there would be a significant reduction in the reading grade level scores with the modified version as compared to the standard version of the system used.

Review of the Literature

Dale and Chall define readability as "... the sum total of all those elements within a given piece of printed material that effect the success that a group of readers will have with it."[3] Among the elements which affect the readability of a document are length use of specialized terminology (jargon), sentence structure and use of polysyllabic words. Other factors which affect the readability of such materials are patient centered factors such as age, cognitive ability, education level, and in the case of the COPD patient, the degree of hypoxemia/hypercapnia induced cerebral dysfunction.

All of the above factors interact to a greater or lesser degree in determining the ability of a given individual to read and

understand materials presented to him by patient educators. It is generally recognized that the American public, on the average, reads at a 6.5 to 8.5 grade level. Christ and Pharr in discussing the readability of informational brochures pose the following question "... at what level should information brochures be written? ... some research seems to suggest that ... it would be reasonable to use a 7th-8th grade readability level as a standard."[4] Smith maintains that "Census information shows that the mean educational level for persons 25 and older is 12.3 years. Research, also, indicates that about half of the 12th graders read on or above the 12th grade level while about 87% of them read above an 8th grade level."[5] Monteith citing Fishers work states that 37% of the adult population "reads below an equivalent of 8.0 on standardized tests."[6]

Several types of 'readability' indices have been developed. As with any instrument readability formulas do have their limitations; however, if used in the context for which they are meant, e.g., as a means of predicting difficulty, the information they yield is useful. The scores produced as a result of using these instruments are inversely related. The higher the score the lower the readability of the document. Conversely, the lower the score the less difficult and more readable is the document.

It is important to begin with a clear picture of what readability formulas can and can not do. What they can do is predict a level of reading difficulty based on an analysis of sentence and word length in a given passage. What they can not do is to take into account the intraperson variables listed above or the actual content of the

materials. Hittleman has pointed out that "... word frequency and sentence length do not stand in simple relationship to reading difficulty ..."[7]

In other words, the level of difficulty is correlated to the length of words and sentences, however, other factors must also be considered. Arguments have been made that high scoring materials should be rewritten to produce lower scoring materials. The very nature of PEMs raises the scores and attempts to rewrite them may result in gaps which the patient may have to fill in themselves. Although the patient may have less difficulty reading the PEM, his understanding of the material, when related to the purpose of the PEM, may well be reduced. One possible method of reducing the score without rewriting the text was suggested by Standal.[8] He proposed making an adjustment in the formula for vocabulary. The educator would identify words whose meaning he felt ought to be taught to the reader as vocabulary words. The reader would then be taught or presented with these words in a vocabulary format as an introduction to the PEM. These words, usually greater than two syllables, are then counted as only having one syllable and are therefore excluded from the calculation. Standal's procedure supposedly lowers the score, making the text more readable.

For the purpose of this study an instrument which was simple to apply and which gave a score indicative of the documents grade level readability was selected. This instrument is called the SMOG Index. This instrument was developed in 1969 by McLaughlin[9] and is highly correlated (rho = 0.985, standard error of estimate = 1.5159 grade

levels) to the standard McCall-Crabbs criterion, which has been the benchmark against which all readability formulae have been measured since 1925.[10] Interinstrument correlations between the SMOG Index and the other two most widely used scoring systems (Fry and Dale-Chall) is , also, extremely high with Spearman Rank Correlations at $p = 0.001$ of rho = 0.87 for Dale-Chall and SMOG, and rho = 0.80 for Fry and SMOG.[11]

It should be noted that both the Fry and Dale-Chall measures are predicated on a prediction criteria of 50-75% comprehension by the reader, while the SMOG measure is predicated on a 90-100% comprehension. Of further interest is the fact that the SMOG Index is consistantly two grades higher than either the Fry or the Dale-Chall.[9, 10, 11] The differences between the 50-75% criterion of the Fry and Dale-Chall and the 100% comprehension of the SMOG Index may account for this discrepancy.

Method

Thirty patient education pamphlets dealing with respiratory diseases were obtained from voluntary health agencies, commercial organizations and three teaching hospitals in the Kansas City area. Ten of these were chosen as representative samples. This was accomplished by numbering the PEMs from one to thirty and then using a random number generator to select ten numbers from one to thirty. The numbers selected indicated the PEMs to be analyzed.

In order to determine the readability of the sample documents the SMOG Index was chosen as the analysis tool. This instrument purports to measure the 'readability index' in terms of grade level of reading

ability. The analysis procedure consists of the following steps:

1. Take thirty sentences, ten each from the beginning, middle, and end of the document.
2. Exclude all proper names.
3. Count the number of words with more than two syllables.
4. Take the square root of the number resulting from the count.
5. Add 3 to the square root.
6. The resultant number is the grade level at which the text can be read.

As a mathematical expression the procedure appears as shown in figure 1.

To provide a measure of comparison of the reading difficulty level, figures 2 and 3 compare the reading difficulty at various stages of education and the difficulty of some commonly used documents.

It should be noted that the SMOG Index score of a given document is dependent on several factors in addition to the length of the words used. The length of the sentences will have a direct impact on the score. When one stops to think about it, it becomes obvious that the longer the sentence, the more opportunity there is to use long complex words and the more individual words the sample passages will contain. The use of technical terms, phrases, acronyms, and abbreviations also will tend to obscure meaning for the ininitiated.

Statistical Methods

Each of the ten sample documents were analyzed for readability using the SMOG Index as an analysis tool. Simple descriptive statistics were calculated from the grouped scores. Additional

analysis was performed using Standal's procedure and simple descriptive statistics were again calcalated. The raw score data for both groups were subjected to analysis by t-tests for grouped data and by a Z-test analysis using the Basic Business Software "Statistics" (Apple II version). This was done for both the raw data and for 'index' scores using the national average reading level (7.5) as the population mean.

Results

Calculation of the simple descriptive statistics resulted in the determinations which are presented in figure 4. Additionally a 1-tailed student's t-test for paired observations was performed on both the raw score data and the index score data to test the hypothesis that the Standal's procedure would result in a significant reduction of the reading difficulty level. This hypothesis was upheld as is shown by the results of the t-tests presented in figure 4 (Raw score $t = 8,343$, $p <= 0.005$, $df = 9$).

Conversion of the raw score data to grade level index data produced the results shown in figure 5. Again, the results of the t-test for paired observations showed significant differences between the methods ($t = 7.307$, $p <= 0.005$, $df = 9$).

Analysis of the sample vs population means was accomplished using a z-test to determine the differences between the means for both the SMOG Index and Standal's procedure as measured against the population mean of grade level 7.5. The results of this analysis as shown in figure 6 indicate that there is a significant difference between the rated readability of the sample documents and the ability

level of the general population.

Discussion

A concrete example of a new technique is often desirable. As such an example, the following passage from the excellent article by Feery, Weller, and Solliday, in the May, 1985 issue of Respiratory Care[12] has been reproduced and analyzed counting not only polysyllabic words, but also, technical jargon. (all indicated by underlines). The authors hope that this example will clarify both the use of the SMOG Index and Standal's procedure and illustrate the potential benefits to be gained through their adaptation, when producing PEMs.

> "It has been common practice to test the respiratory drive of a comatose patient by disconnecting him from the ventilator and observing him for spontaneous ventilatory efforts. Our experience argues against this practice. Five (22%) of our patients (Patients 4, 13, 14, 17, and 23) had a potentially dangerous fall in PaO2 and Patient 23 also developed an arrhythmia during apnea testing. Furthermore, if the clinical search for spontaneous respiratory efforts is not aided by instruments to continuously measure and record these efforts, then very small attempts at breathing may be missed by the observer, or gross movements due to spinal reflexes may be mistaken for ventilation.
>
> Our procedure is an improvement over earlier attempts at safer and more effective apnea testing. The exact apparatus and protocol for apnea testing may differ among institutions, but there are several points that we believe to be important.

First, diffusion respiration is effective in maintaining adequate PaO2 in the majority of nonbreathing patients providing there has been adequate denitrogenation. Second, the application of CPAP further increases the likelihood that PaO2 will be maintained. Third, because the goal of apnea testing is to allow PaCo2 to rise to a level at which it is a strong ventilatory stimulus, frequent monitoring of PaCO2 is necessary to recognize when this point is reached so as not to discontinue a test prematurely or prolong it needlessly. The wide variation among patients in the rate of rise of PaCO2 makes it difficult to recommend one duration of testing for all."

A count of the underlined items in the above passage reveals a total of 65 underlined items. If we accept that the remaining two samples of ten sentence each needed to obtain a SMOG Index from, this paper would have relatively the same the SMOG Index for this paper would be in the area of 17.0 (This is not an indictment of this paper, the score seems appropriate for it's intended audience). However, based solely on the readability score, this paper would clearly be inappropriate for the lay audience. Use of the Standal procedure would lower this score, but not appreciably. Examples 1a, 1b, and 1c illustrate the analysis by both methods and indicate the reduction in grade level by use of Standal's procedure. The SMOG Index score of 16.95 obtained by analysis of the sample indicated a required reading level equivalent to that of a first year graduate student. Application of Standal's procedure (modified by inclusion of technical terms in

the screening process as discussed above) resulted in a reduction of the reading level index to 14.22 This is equivalent to the reading level of a second year college student. While the reduction of 2.73 grade levels appears to be satisfactory for the intended group, the ability of the material to be easily read and comprehended by a lay audience would not be greatly enhanced.

Conclusions

The ability to provide the patient with educational materials relating to the patient's disease, methods of treatment, and techniques designed to minimize the effects of the disease and it's symptoms are an important facet of the rehabilitation process. The value of such materials is directly related to the patient's ability to read and understand the materials presented. The current study has shown that, for the limited sample analyzed, a significant portion of the target population may be at a significant disadvantage in terms of the ability to adequately read and comprehend patient materials now available.

Use of readability formulae, such as the SMOG Index, allows the patient educator to determine the suitability of materials for his or her patient population. These formulae, in conjunction with vocabulary training, can permit the educator to 'fine tune' the teaching documents to the patients level of comprehension. Inclusion of a vocabulary section in patient education materials would seem to be highly desirable. None of the materials reviewed in this study had a readability index of less than 2.92 grade levels higher than the average reading level of the U.S. population when the SMOG Index was calculated. Application on Standal's procedure had the effect of

lowering the gap between the population average and the lowest measured index score to 1.98 grade levels. This was a significant reduction, but still resulted in a potential comprehension deficit.

The authors conclude that readability formulas have a potential role in evaluating patient education materials. We do, however, caution that this potential may be limited to serving as a guideline as not all patients will have the same reading ability. We, therefore, suggest that questions regarding the patient's (and family's) educational attainment be incorporated as part of the patient evaluation process. We further conclude that the use of vocabulary training and the inclusion of a vocabulary at the beginning of each document will result in a more readable and therefore more valuable document.

We would like to leave the reader with a final thought quoted from Lorge:

> "Readability formulae are no panacea. They do not tell anything about the ideas expressed or the interrelationships among them. At best, they are yardsticks. If they are not inflated into a recipe for writing, they are useful adjunct in the evaluation of written and spoken materials. Their use, however, cannot be a complete substitute for the wisdom of experience."[13]

Legends for Figures

Figure 1. Smog Index Formula

Figure 2. Index Scores vs Level of Education

Figure 3. Smog Index Scores of Selected Publications

Example 1a. Smog Calculation of Speciman Document

Example 1b. Modified Smog Calculation of Speciman Document

Example 1c. Effect of Standal's Procedure on Speciman Document

Figure 4. Simple Statistics (Raw Scores)

Figure 5. Simple Statistics (Index Scores)

Figure 6. Z-Test Score Table

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$$\text{SMOG INDEX} = 3 + \sqrt{(Wa + Wb + Wc)}$$

Where: Wa = # of words > two syllables in 1st ten lines.
Wb = # of words > two syllables in middle ten lines.
Wc = # of words > two syllables in last ten lines.

Figure 1: SMOG INDEX FORMULA

INDEX COMPARISON

EDUCATION	INDEX
College	13 - 16
High School	9 - 12
Sixth Grade	6

Figure 2: INDEX SCORES vs LEVEL OF EDUCATION

EXAMPLES

SOURCE	SMOG INDEX
Federal Register	20.95
Respiratory Care	14.70
The Atlantic	13.95
People	10.87
Newsweek	10.58

Figure 3: SMOG INDEX SCORES OF SELECTED PUBLICATIONS

READABILITY SCORES

SPECIMEN: "The Use of Apneic - Diffusion Respiration in the Diagnosis of Brain Death" *

SMOG (Standard):

WA = 65 (analyzed)
WB = 65 (assumed)
WC = 65 (assumed)

$$\text{SMOG INDEX} = 3 + \sqrt{WA + WB + WC}$$
$$SI = 3 + \sqrt{65 + 65 + 65}$$
$$SI = 3 + \sqrt{195}$$
$$SI = 3 + 13.96$$
$$SI = 16.95$$

*Feery, J.J.; Waller, G.A.; Solliday, N.; Respiratory Care; V 30, N 5, May 1985, p. 328-333.

Example 1a: SMOG CALCULATION OF SPECIMEN DOCUMENT

READABILITY SCORES

SPECIMEN: "The Use of Apneic - Diffusion Respiration in the Diagnosis of Brain Death" *

SMOG (STANDAL's PROCEDURE):

WA = 42 (analyzed)
WB = 42 (assumed)
WC = 42 (assumed)

$$\text{SMOG INDEX} = 3 + \sqrt{WA + WB + WC}$$

$$SI = 3 + \sqrt{42 + 42 + 42}$$

$$SI = 3 + \sqrt{126}$$

$$SI = 3 + 11.22$$

$$SI = 14.22$$

* Feery, J.J.; Waller, G.A.; Solliday, N.; Respiratory Care; V. 30, N.5, May 1985, p. 328-333.

Example 1b: MODIFIED SMOG CALCULATION OF SPECIMEN DOCUMENT

READABILITY SCORES

SPECIMEN: "The Use of Apneic - Diffusion Respiration in the Diagnosis of Brain Death" *

Standard SMOG Index	16.95
Standal's Procedure	14.22
Change in grade level	2.73

* Beery, J.J.; Waller, G.A.; Solliday, N.; Respiratory Care; V 30, N5; May 1985; p. 328-333.

Example 1c: EFFECT OF STANDAL's PROCEDURE ON SPECIMEN DOCUMENT

RAW

	SMOG		STANDAL
N	10		10
MEAN	88.5		67.8
RANGE	55-114		42-100
SAMPLE VAR.	365.17		304.40
SD SAMPLE	19.11		17.45
POP. VAR.	328.65		273.96
SD POP.	18.13		16.55
STD. ERR.	6.04		5.58
t-statistic		8.343	
t-prob.	<	0.005*	

Figure 4: SIMPLE STATISTICS (RAW SCORES)

	SMOG	STANDAL
N	10	10
MEAN	12.38	11.23
RANGE	10.42-13.68	9.48-1300
SAMPLE VAR.	1.103	0.977
SD. SAMPLE	1.05	0.987
POP VAR.	0.993	0.876
SE MEAN	0.332	0.312
t-statistic	7.307	
t-prob.	<=0.005*	

Figure 5: SIMPLE STATISTICS (INDEX SCORES)

	SMOG	STANDAL
df	9	9
Z-score	15.43*	11.80*
p	< 0.001	< 0.001

Figure 6: Z-TEST SCORE TABLE

CONCLUSIONS

1. A large proportion of the population may be at a disadvantage when required to read and comprehend PEM's.

2. Use of readability formulae, especially in conjunction with vocabulary reviews, may decrease the problems associated with reading in this portion of the population.

3. Patient assessment interviews should include assessment of the patients education status.

4. Patient education materials should contain a vocabulary list at the beginning of each document.

Figure 7: CONCLUSIONS

RECOMMENDATIONS

Further research in this area should include studies of:

1. Larger numbers of specimen documents.

2. The effects of vocabulary vs no vocabulary training on the understanding of PEM's by patients.

Figure 8: RECOMMENDATIONS FOR FURTHER STUDIES

"NOTHING IN THIS ACT SHALL BE CONSTRUED AS PROHIBITING OR PREVENTING AN INDIVIDUAL LICENSED UNDER OTHER LAWS FROM PERFORMING DUTIES OR FUNCTIONS COVERED UNDER THEIR SCOPE OF PRACTICE FOR WHICH THEY HAVE ADEQUATE TRAINING AND KNOWLEDGE."

"IN CASES WHERE HARM MAY COME TO THE PATIENT WITHOUT IMMEDIATE ACTION, AND WHERE A PHYSICIAN IS NOT AVAILABLE THE PERSON LICENSED UNDER THIS ACT MAY INSTITUTE THOSE FUNCTIONS HEREIN DEFINED, AT THE MINIMUM LEVEL NECESSARY TO PREVENT HARM, WITHOUT THE ORDER OF A PHYSICIAN."